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Railway Track Crack/Obstacle Detection System using IR Sensor

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Abstract: *In the fast-developing country, people are facing many accidents; it would be undesirable for any nation to lose their life for an unwanted cause. Railways are one of the important transports in India. There is a need for manual checking to detect the crack on railway track and railway personnel always take care of this issue, even though the inspection is made regularly. Sometimes the crack may go unnoticed. Because of this the train accident or derailment may occur. In order to avoid this situation and automate the railway crack detection has been proposed. Here IR sensor is used to detect the crack in the railway track and detect the obstacle presence in the track, here we are Using Arduino microcontroller. This project pertains to a process for monitoring the condition of rail on train tracks and more specifically has the object of the identification of defects detected by IR sensors on the tracks to be checked to allow maintenance crews to subsequently find these defects. The 3 D model will be drawn with the help of CATIA software. All the components will be manufactured and then assembled together. After making the assembly, the experimental testing will be carried out. After the testing, the result and conclusion will be carried out.*

Keywords: Arduino microcontroller, IR sensor, CATIA software, GSM module, AVR Controller, D.C. Motor, etc.

I. INTRODUCTION

Depending on the fast developments in railway systems, high-speed trains are used, and rail transportation is increased day by day. Today's most of the people uses railway for transportation, it is essential for transferring the goods and passengers from one place to another place. And also, the railway system is provided facility such as high speed, with economical, environment friendly, safety, and better characteristics of railway systems. These characteristics can be performed by time-to-time maintenance and control measurements. But depending on different factors, deformations and derailment may occur on the superstructure of railways. These derailments and other problems of railway system like, improper maintenance and the currently irregular and manual track line monitoring mistake from workers. Such deformation and derailment are determining on time and taking precautions is very important for the safety of railway systems.

In India most of the commercial transport is being carried out by the railway network and therefore as any problem occurred during transportation the major damage is getting occurred to the Economy non-withstanding a social life. This paper presents an implementation of an efficient and cost-effective solution suitable for railway application. The Indian railway network today has a track length of 113,617 kilo-meters (70,598mi) over a route of 63,974 kilo-meters (39,752mi) and7, 083 stations. It is the fourth largest railway networking the world exceeded only by those of the United States, Russia and China. The rail network traverses every length and breadth of India and is known carry over 30 million passengers and 2.8 million tons of freight daily. Despite boasting of such impressive statistics, the Indian rail network is still on the growth trajectory trying to fuel the economic needs of our nation. In terms of the reliability and safety parameters, we have not yet reached truly global standards.

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Though rail transport in India growing at a rapid pace, the associated safety infrastructure facilities have not kept up with the aforementioned proliferation. Our facilities are inadequate compared to the international standards and as a result, there have been frequent derailments that have resulted in severe loss of valuable human lives and property as well. The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rail sand other similar problems caused by antisocial elements which jeopardize the security of operation of rail transport.

The object of the identification of defects detected by monitoring equipment on the tracks to be checked to allow maintenance crews to subsequently find these defects. Two medal sensors are fixed in the wheels of the train is used to find out the crack on the rail. Each sensor will produce the signal related position with the rail. If the track is said to be normal on its position when both the sensor gives the constant sensed output. If anyone misses their output condition to fail then there is defect on that side. It will inform this by giving alarm. Where sensors and alarm should connect to the microcontroller I/O lines and microcontroller is programmed to our needs.

II. LITERATURE SURVEY

The paper [1] relates to the detection of cracks in the railway tracks using IR sensor. According to a possible embodiment, the railway carriage carrying the control equipment's is provided with sensor orientated to detect the crack. This project pertains to a process for monitoring the condition of rail on train tracks and more specifically has the object of the identification of defects detected by monitoring equipment on the tracks to be checked to allow maintenance crews to subsequently find these defects. Two medal sensors are fixed in the wheels of the train is used to find out the crack on the rail.

This paper [2] proposes a cost-effective solution to the problem of crack detection of rail track utilizing IR sensors which detect the exact location of faulty tracks which then system operated immediately so that many lives will be save and avoid the railway accident This project is implementation of with LPC2148 microcontroller using GSM module and GPS receiver. Here IR sensors are used to found the crack in the track, whenever crack is detected GPS receiver receives the location information. This information of the crack detecting is sent to the railway authority by using GSM system. Whenever the crack is detected, a buzzer will be activated to alert the surroundings and message will send automatically to the controlling station of railway authority.

This paper [3] aims for the detection of cracks in railway tracks, distance between the tracks and the presence of humans on railway tracks. The design of system consists a Global Position System (GPS) module, Global System for Mobile (GSM) modem, Infrared (IR) sensor and Passive Infrared (PIR) sensor. Now a days, the cracks in the railway track are measured by a high-cost Linear Variable Differential Transformer (LVDT) with a less accuracy. In proposed system, the IR sensors are used for detect the crack in the rail track, ultrasound sensors measure the distance between the two track and the PIR sensors are used to detect the presence of humans the track.

This paper [4] is done with Aim towards addressing the issue by developing an automatic Railway track detection system integrating an infrared IR crack Sensing module based on GSM technology by which information about the location of the crack can be conveyed to the central Location enabling immediate attention and intervention of the Maintenance personals. The whole construction of automatic railway track crack detection system consists of various components. It includes GSM module, GPS receiver, Arduino board, GPS antenna, IR sensor, Battery and DC motor. The working platform for the whole system is Arduino board.

The GSM module is interfaced with Arduino through coding or programming. Similarly, the GPS receiver is also interfaced with Arduino through a specified program. The GPS i.e., the global positioning system here plays a major role in the whole system, this is used to determine or to lock the exact location of the crack where the crack is being detected. The longitude and latitude of the exact crack location is determined through GPS antenna.

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The GSM Module also plays a vital role in the whole system. It is used to pass the message to the nearby station or maintenance centre.

The paper [5] ultrasonic sensor is used to detect the crack in the railway track by measuring distance from track to sensor, if the distance is greater than the assigned value the microcontroller identifies there is a crack and IR sensor is used to detect the obstacle presence in the track, here we are Using Arduino microcontroller. After crack detection or object detection the testing robotic vehicle stops and the longitudinal and latitudinal positions are sent via SMS to GSM and GPS and also send the information to nearby trains through RF Communication, Here RF Transmitter is placed on Robotic Section and RF Receiver is placed on Train section. The cost of the proposed system is very less.
It also checks surface and near surface of the cracking position. Transmitting signals are immediately transferred and accidents are reduced. It can work in any terrain 24*7 and detects cracks accurately. The project is developed and designed to improve rail track management and the main aim of project is to reduce man power. By using this project, we can detect crack in railway track and obstacle on the track. In the proposed method Ultrasonic sensor is used to detect the crack and IR sensor is used to detect object on the track. The robotic section continuously checks the crack and obstacle. Location of crack and obstacle is detected by GPS and then send to authority by GSM and also sends the information from Robotic section to near train sections through RF Communication.

III. IMPLEMENTATION

Step 1: - We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through these papers, we learnt about Automatic Seed Sowing machine.
Step2: - After that the components which are required for our project are decided.
Step 3: - After deciding the components, the 3 D Model and drafting will be done with the help of CATIA software.
Step 4: - The components will be manufactured and then assembled together.
Step 5: - The testing will be carried out and then the result and conclusion will be drawn.

i) Components Used:

The main components of the automatic railway track crack detecting vehicle are:

- IR Sensor
- Arduino
- D.C. Motor
- Battery
- Body
- GSM Module
- Power Supply Circuit
- AVR Controller

ii) Design:

The main design considerations are Spur Gear and Bearings.

A) Spur Gear

Diameter of the motor gear wheel (D1) = 36 mm
Diameter of the Shaft Gear Wheel (D2) = 72mm.
Speed of the Motor (N1) = 60 RPM
Speed of the shaft wheel (N2) = (D1 / D2) x N1 = (36 / 72) x 30 = 15 RPM

B) Bearing Bearing No. 6202

Outer Diameter of Bearing (D) = 35 mm. Thickness of Bearing (B) = 10 mm.

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Inner Diameter of the Bearing (d) = 15 mm. r1 = Corner radii on shaft and housing.
r1 = 1(From design data book).
Maximum Speed =14,000 rpm (From design Data book)
Mean Diameter (dm) = (D + d) / 2 = (35 + 15)/2 =25 mm.

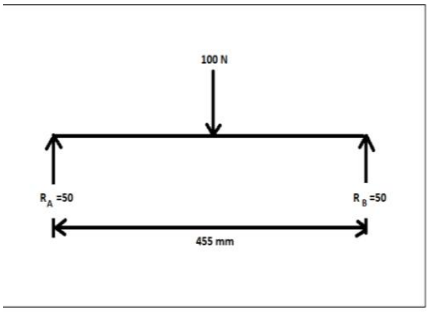
iii) Basic Design Calculations:

A) Motor Selection-

Let the total mass of the system be m=10kg.
So, the total vertical force acting =100 N.
This force is distributed over the four wheels so for each wheel, F= 25 N.
Now the required torque to move the system for 3-inch radius wheels,
Treq = Vertical acting force*Radius of wheel = 25*75 =1875 N-mm
Now to move the system the supplied torque should be greater than the required torque,
So, for 60 Watts DC motor (12V and 5A) and N=60
P = 2*3.14*N*T/60 T
Sup = 60*60/2*3.14*60 Tsup=9549 N-mm.
As the supplied torque is greater than the required torque our design is safe, and we can select 12V and 5A DC motor.

B) Frame Design

For equilibrium condition, ΣMA=0
Hence reactions at A and B= 50 N
Now we have to design the frame against the bending failure and system should be in elastic limit so our maximum upper limit is Syt of the MS material i.e., 210 N/mm2.
Now the maximum bending moment is occurred at point C.
So, BM about C=100*227.5=22750 N-mm
According to flexure formula by considering the pure bending moment, M/I=σ/Y



Where,

M= Maximum bending moment at point C= 22750N-mm
I=Moment of inertia of the square section
Y= Distance of neutral axis from the upper layer = For 1-inch square pipe= 25/2= 12.5 mm
σ= Induced bending stress in N/mm2
Now as we are using the 1-inchsquare hollow pipe with 3 mm internal thickness.
I1=bd^3/12= (25)*(25)^3/12= 32552.08
mm^4
I2=BD^3/12= (22)*(22)^3/12=19521.33
mm^4
I=I1-I2 =32552.08-19521.33 I=13030.75 mm^4

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Substituting these values in the above equation, σ= 21.28 N/mm2
As the induced stress is less than the Syt of the material our design is safe.

IV. CONCLUSION

This project pertains to a process for monitoring the condition of rail on train tracks and more specifically has the object of the identification of defects detected by IR sensor on the tracks to be checked to allow maintenance crews to subsequently find these defects. The proposed system is not only overcome problems like time consumption and price range but also improve accuracy and crack detection in rails. It is the most economical solution provided in order to achieve good results of railways of our country in order to minimize the stats of accidents caused. There by possible to save precious lives of passengers and loss of economy. It also saves the time and money for identification of crack. The approach taken is capable, if there are any, of detecting flaws and obstacles on the surface.

The method proposed has lots of advantages over conventional detection approaches that include minimal cost, reduced energy consumption, efficient detection system without human involvement and shorter analytical times. With this prototype, train collisions and derailments can be easily prevented to save many lives. It is also very beneficial for railroad operations testing units. When we use the detector model for monitoring and we can claim that it is a fusion energy vehicle. The result shows that this exciting new technology will keep increasing the efficiency of the safety features for rail infrastructure. We can prevent accidents of up to 70% by enforcing these functionalities in the real-time implementation. Areas where manual testing is not feasible with this vehicle, such as in shallow coalmines, mountainous areas and thick and deep forests regions, can be easily carried out. When this vehicle is used for railway inspections and breakage detection. This will lead without errors to the management and control of the state of the railway tracks, and thus to the preservation of the tracks in good condition.

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